

# Evaluation of Clinical Data by Remote Observation in Trauma

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## INTRODUCTION

The use of telecommunications for medical diagnosis and patient care is finding new applications in a variety of disciplines. Telemedicine relies heavily on remote audio and video observation for patient evaluation and management. Trauma care has evolved into a highly specialized field of surgery where experience and judgment may have a major effect on clinical outcome. Prior to implementing telemedicine for remote diagnosis in trauma care, the limitations of video observation must be critically assessed and documented. This study analyzes trauma resuscitation into its component parts by using one-way video and audio observation. This will help define the feasibility and pitfalls associated with the development of remote consultation techniques for trauma care. Video observation of trauma resuscitations has previously been used for education and quality assurance purposes only. 1-3 These studies reviewed videotaped resuscitation for trauma to assess trauma team performance and provide educational feedback. To our knowledge, video observation has not been previously tested as a medium for assessing clinical data in injured patients.

This study had three specific goals:

- 1) To assess the feasibility of remote clinical data assessment in trauma.
- 2) To assess reliability of data gathered by remote video and voice observation.
- 3) To test an Advanced Trauma Life Support (ATLS)4 based clinical data form, using 44 variables, for determining the accuracy of remote observation in the evaluation of traumatic injuries.

This represents a pilot project upon which an interactive remote consultation for acute trauma care will be designed and assessed.

## METHODS

The Ben Taub General Hospital is a Level 1 trauma center with over 3,000 trauma admissions per year. Five resuscitation rooms are linked to the trauma coordinator's office by a closed circuit analog video system installed for quality assurance purposes. In the trauma coordinator's office, 24 trauma resuscitations were single-pass viewed during July and August 1996 and were erased after review. Forty four clinical variables were recorded for each resuscitation on an ATLS based clinical data form. Observed variables recorded on the form were compared with charted variables on each patient's medical record for agreement or disagreement. If a variable was not documented on either the ATLS form or the medical record, the variable was categorized under insufficient information.

Trauma resuscitations were observed from a 3 meter high wall-mounted videocamera and microphone providing a room view perspective. The cameras are linked to a motion detection grid and captures activity surrounding a patient with NTSC quality imaging. The videotapes are timecoded to allow accurate recording of time. Time spent in a resuscitation room is defined as the time from patient arrival until departure from the resuscitation room. Any diagnostic testing done outside a resuscitation room is not included in the trauma resuscitation time.

Videotaping and subsequent tape reviews are part of the hospital's internal quality assurance program. There were no deviations from routine quality assurance protocols for handling resuscitation tapes. This assured protection from discoverability for civil proceedings, a sensitive subject of recent controversy. Approval for this study was obtained from the institutional review board and patient anonymity was maintained. Resuscitations occurring at night and which required hospital admission were reviewed the next morning to

allow immediate comparison between the data from the video resuscitation and the data from the patient's chart.

Each patient was assigned 2 triage revised trauma scores (TRTS) which indicates the severity of injury 5 . One TRTS score was calculated from video observation of a resuscitation, and the other score was calculated from data in a patient's chart. TRTS scores were calculated for all 24 patients. The average score was 10.1 (range 0-12). Fifteen patients had a score of 12, and two patients had a score of zero. All patients reviewed for this study underwent hospital admission. One patient died upon admission. Standard evaluation and treatment was applied to all patients and was not modified by the techniques of this study. The trauma team consists of 2 first year surgical residents, a third year resident, and ancillary personnel. Supervision is provided by a chief (fifth year) surgical resident and an on call staff surgeon.

## RESULTS

The 44 variables were categorized into 8 groups: demographics, primary survey (ABCDE), initial vital signs, ancillary studies, secondary (2°) survey patient history, secondary vital signs, 2° survey physical exam, diagnosis and disposition. Agreement rates for each of these eight groups of variables are show in tables 1 through 8. Except for variables 39 and 40, the sum across a row equals 24 (the total number of patients). Data explanation follows each table.

Table 1 - Demographics

		Agree	Disagree	Insufficient
1	AGE	17	5	2
2	SEX	24	0	0
3	MOI	24	0	0

MOI = mechanism of injury

High agreement among variables 1, 2 and 3 are based on vocalization of this information by paramedics upon a patients arrival. Age was sometimes unknown or undocumented.

Table 2 - Initial Vital signs

		Agree	Disagree	Insufficient
4	RR	2	0	22
5	BP	10	2	12
6	HR	1	6	17
7	TEMP	0	0	24
8	O2 SAT	3	0	21

RR = respiratory rate, BP = blood pressure, HR = heart rate, TEMP = temperature, O2 SAT = oxygen saturation

Low agreement of variables 4 through 8 was due to the inability to view monitoring devices and the infrequent vocalization of the vital signs by the trauma team. Subsequent implementations of remote trauma management may overcome this limitation by the use of multi-channel telemetric monitoring and by adding the ability to prompt the team for additional information.

Table 3 - ATLS Primary Survey

		Agree	Disagree	Insufficient
9	A	23	1	0
10	B	23	1	0
11	C	21	0	3
12	D	24	0	0
13	E	24	0	0

A = airway, B = breathing and ventilation, C = circulation and hemorrhage control, D= disability and neurologic status, E = exposure

Variables 9 through 13 represent the first steps in the evaluation and treatment of the seriously injured patient. High agreement rates between remote observation and charted records are probably based partly on direct observation and partly on secondary extrapolation from observed behavior of the trauma team. For example, a resident or nurse seen to converse with the patient is indirect evidence of airway patency, although direct visualization of the airway was not possible. Tools such as video fiberoptic nasopharyngoscopy may allow direct assessment of the traumatized airway in future telemedicine applications.

A general neurologic assessment could be made by watching the resident perform a neurologic exam. Organized structuring of such an exam may allow a more refined assessment, with calculation of the Glasgow coma score. In the majority of these cases only a global neurologic assessment was recorded.

Table 4 - Ancillary studies

		Agree	Disagree	Insufficient
14	CXR	24	0	0
15	PELVIS	23	1	0
16	C-SPINE	24	0	0
17	FOLEY	24	0	0
18	NGT	23	0	1
19	IVF	23	0	1
20	ECG	18	0	6
21	T&C	17	0	7
22	LABS	12	0	12

CXR = chest x-ray, PELVIS = pelvis x-ray, C SPINE = cervical spine x-ray, FOLEY = foley urine catheter, NGT = nasogastric tube, IVF = intravenous fluids, ECG = electrocardiogram, T&C = type and crossmatch, LABS = laboratory studies

Variables 14 - 22 represent ancillary studies, such as labs and x-rays, and adjunctive procedures, such as gastric and bladder intubation. Agreement in table 4 reflects the observation that the item was requested or performed. For Table 4 variables, the observation strategy is similar to that used in quality assurance studies. Agreement does not reflect knowledge of study results. Two practical solutions to this limitation are envisioned: a) a trauma team member can report or interpret the study result and communicate the information to the remote consultant for judgment based advice, or b) telemetry and digital transmission of waveforms, numeric data and images can be sent directly to the consultant for interpretation. The latter arrangement will be technically more demanding and costly. Its benefits should be carefully compared against the alternative prior to large scale implementation.

Table 5 - Secondary Survey, History

		Agree	Disagree	Insufficient
23	HPI	21	2	1
24	PMH	23	1	0
25	PSH	21	3	0
26	MED	22	0	2
27	ALL	23	0	1

HPI = history of present illness, PMH = past medical history, PSH = past surgical history, MED = medicines being taken, ALL = allergies

After the primary survey is performed to rule out immediately life threatening injuries and initial stabilizing procedures have begun, ATLS protocol calls for a detailed history and physical examination. High agreement rates in variables 23 to 27 indicate that the history can be accurately recorded based on audio monitoring. Vocal feedback may allow a consultant to expand the history using a trauma team member as a proxy history taker. Whether such a technique would improve on the quality of the trauma history will be difficult to assess and will require a detailed analysis of history data points.

Table 6 - Secondary Vital signs

		Agree	Disagree	Insufficient
28	RR	3	0	21
29	BP	3	0	21
30	HR	1	1	22
31	TEMP	0	0	24
32	O2SAT	2	0	22

RR = respiratory rate, BP = blood pressure, HR = heart rate, T = temperature, O2SAT = oxygen saturation

The repeat vital signs measured during the secondary survey were not vocalized enough by the trauma team to achieve high agreement. Blood pressure was recorded by an automatic measurement device, which can take periodic readings as often as every minute. Heart rate and pulse oximetry were usually monitored

continuously. Planned vocalization, positioning of monitors, and direct output to a network are all potential solutions to increasing the agreement rates for vital signs.

Table 7 - Physical exam

		Agree	Disagree	Insufficient
33	H&N	17	4	3
34	CHE	15	4	5
35	ABD	20	2	2
36	DPL	21	1	2
37	P&P	15	1	8
38	B&E	19	2	3

H&N = head & neck exam, CHE = chest exam, ABD = abdominal exam, DPL = diagnostic peritoneal lavage procedure, P&P = pelvis & perineum exam, B&E = back & extremity exam

Agreement of variables 33 to 38 pertaining to the physical exam is based on observing the trauma team member perform the exam and vocalize the result. Positive findings are more frequently vocalized than negative findings. The physical exam is a component of trauma evaluations which will continue to require someone with at least basic training and skill to be present during evaluation.

Table 8 Diagnosis and Disposition

		Agree	Disagree	Insufficient
39	DIAGN	57	11	1
40	THERAPY	79	3	11
41	DISPOS	23	1	0
42	EC TIME	8	4	12
43	MORTA	24	0	0
44	TRTS	3	0	21

DIAGN = diagnoses, DISPOS = disposition, EC = emergency center, MORTA = mortality, TRTS = triage revised trauma score

The number of diagnoses and treatment decisions for each patient varied. Despite the relatively high (83% and 85% respectively) agreement rates, these

agreements are predominantly based on vocalization by team members present, rather than direct collection of data. Subsequent telemedicine applications should carefully address the basis of remote diagnoses and treatment decisions and analyze the safety of remote consultation. Recognizing the appropriate disposition as a need for further evaluation, observation, admission, or operation was based on vocalization by the trauma team leader. None of the 24 patients died in the Emergency Center, although one patient who had an emergency center thoracotomy subsequently died in the operating room. Discrepancies in the recorded Emergency Center times can be attributed to incomplete time logging or asynchronous time keeping. TRTS scores could only be calculated for each patient from data in the medical record and not from observation due to the frequent lack of vocalization of vital signs.

## DISCUSSION

Trauma remains the leading cause of death through the first 4 decades and the 4th leading cause of death nationally 6. Trauma occurs across a wide spectrum of severity and without geographic or social boundaries. An equally broad range of medical, surgical, and ancillary disciplines are called upon to provide initial evaluation of injured patients. Morbidity and mortality in trauma can be significantly altered by timely recognition and treatment of injuries. When trauma patients present to facilities without a high level of experience in trauma or to individuals with limited trauma training, the immediate availability of expert consultation by a trauma specialist could expedite the evaluation and stabilization process. This would likely reduce the need for non-therapeutic transfers and help to expedite inter-facility transfers when needed. The potential for improved utilization of resources, reduction of cost, and increased satisfaction for both referring and referral centers is enormous.

Currently, many important diagnostic, therapeutic, triage, and transfer decisions are made on the basis of a telephone description from a nurse, paramedic, or physician without specialized trauma training. The potential for adding videoconferencing and multi-channel telemetric monitoring could improve the quality of such decisions and even provide guidance during initial care. The potential for porting such an application to a digital network could make expert trauma consultation available at any time, practically anywhere in the world. The successful development of such an application will require the development of new

communication skills and a thorough understanding of the capabilities and limitations of the communication medium. The process of developing such an application, which promises to be one of the most demanding and potentially gratifying roles for telemedicine, will require a detailed examination of the trauma resuscitation process. This process is analyzed into its component parts by the current study.

Based on these results, we have begun the second phase of our project in which we are performing remote evaluation of acutely injured patients upon arrival to Ben Taub using a similar technique, but with the addition of a vocal feedback. Vocal feedback will be via a cordless headset telephone, from an attending staff surgeon monitoring the resuscitation, to the trauma team leader. This technique allows prompting the trauma team leader to obtain additional history, perform specific exams, and discuss options for intervention as the need arises, rather than relying on an after the fact discussion by telephone. We currently exclude patients who meet internal trauma center designation criteria for immediate staff presence. The results of our second phase will be presented when data acquisition and analysis is complete.

## CONCLUSION

Acute trauma care is commonly provided under a wide range of circumstances by individuals with various types of training and experience. Telemedicine may solve several important problems related to the multi-tiered nature of regionalized trauma care and allow the optimization of resources on a large scale. In an attempt to provide a critical analysis of the value of telemedicine, this study examines a series of trauma resuscitations to identify which of its component parts are likely to allow safe and effective application of remote consultation techniques. We discovered remote clinical data assessment to be feasible and relatively accurate. An analog audio-video system was employed for this pilot phase because of its availability and to eliminate the need to concurrently assess the adequacy of digital technology. Prior to justifying the cost of a large scale digital network for trauma care we must develop the technique for its successful application. This will involve a careful examination of our communication skills, thought processes, and decision

making algorithms. We found the current system useful and accurate for the purposes of this initial study. The data form and remote clinical evaluation is expected to continually evolve as the application develops and we become familiar with its pitfalls. By performing this early work in a high volume environment, with the least possible unknown variables, we will be able to focus on the observation and judgment factors that lead to a successful telemedicine program. The next step will be to assess the contribution of interactive multimedia including voice, video, telemetry, and imaging. Once this is established, the optimal network configuration can be defined to provide wide distribution and scalability of service. Security and bandwidth protection will have to be designed into the network configuration. Trauma consultation will likely be one of the most challenging applications for telemedicine techniques because of its emergent nature, wide occurrence and unpredictable patterns. A systematic approach to remote assessment of trauma care holds major implications for education, quality assurance and most importantly, clinical care of the injured patient.

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